An Upward-Looking, Below-Canopy Lidar For Validation of Spaceborne Lidar Products

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for

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CSIRO Canopy Lidar Initiative – Research Team

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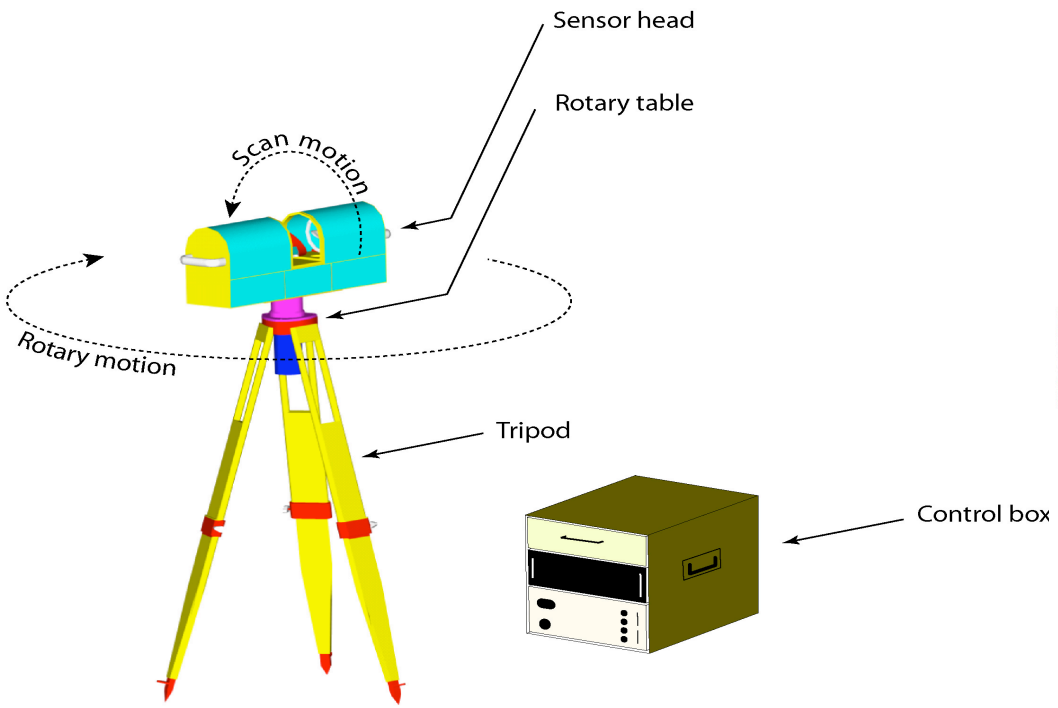
Ground Based Lidar

- ECHIDNA™ is ground based lidar technology designed by CSIRO specifically for forest and vegetation assessment
- CSIRO canopy Lidar Initiative (CLI) has patented ECHIDNA™ and aims to make it operational and commercial in Forestry and Environmental applications
- The ECHIDNA™ and the current prototype – the ECHIDNA™ Validation Instrument (or "EVI") has key differences to scanning rangefinders
  - Digitizes the full 'waveform'
  - Has variable beam divergence
  - Uses full hemispherical scanning
  - Linear response and calibration

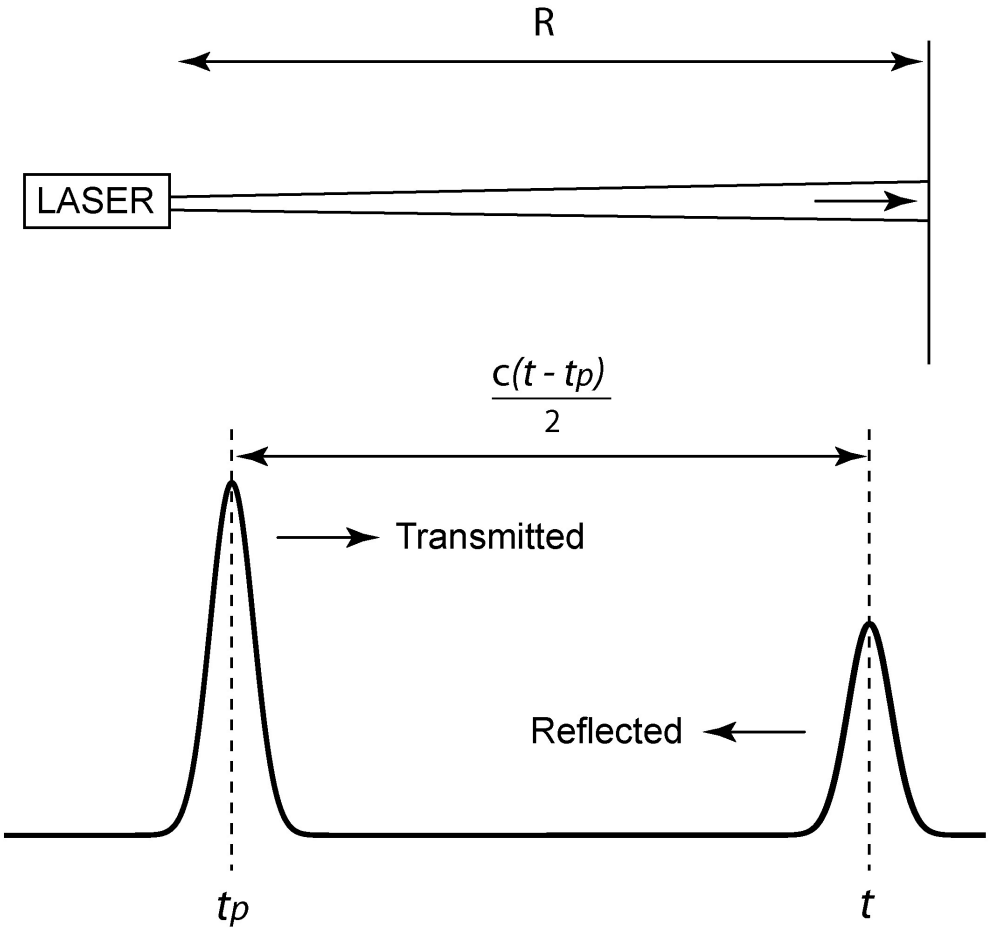
Ground Based Lidar (ECHIDNA™)



A “Real” Echidna – in the forest

EVI (The ECHIDNA™ Validation Instrument)

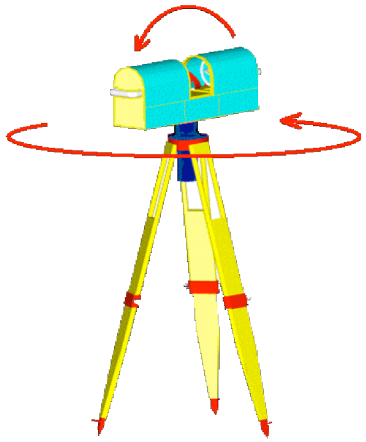
Principles of Lidar Ranging

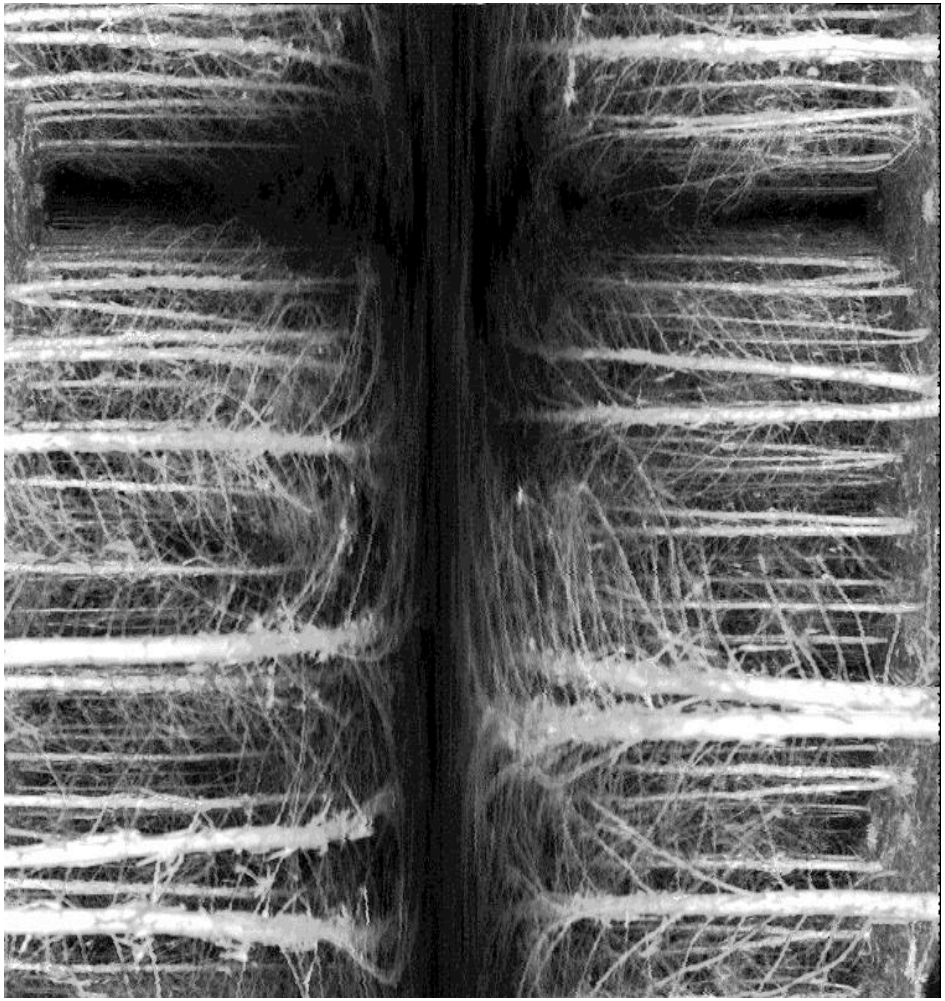


EVI data geometry

← Zenith →

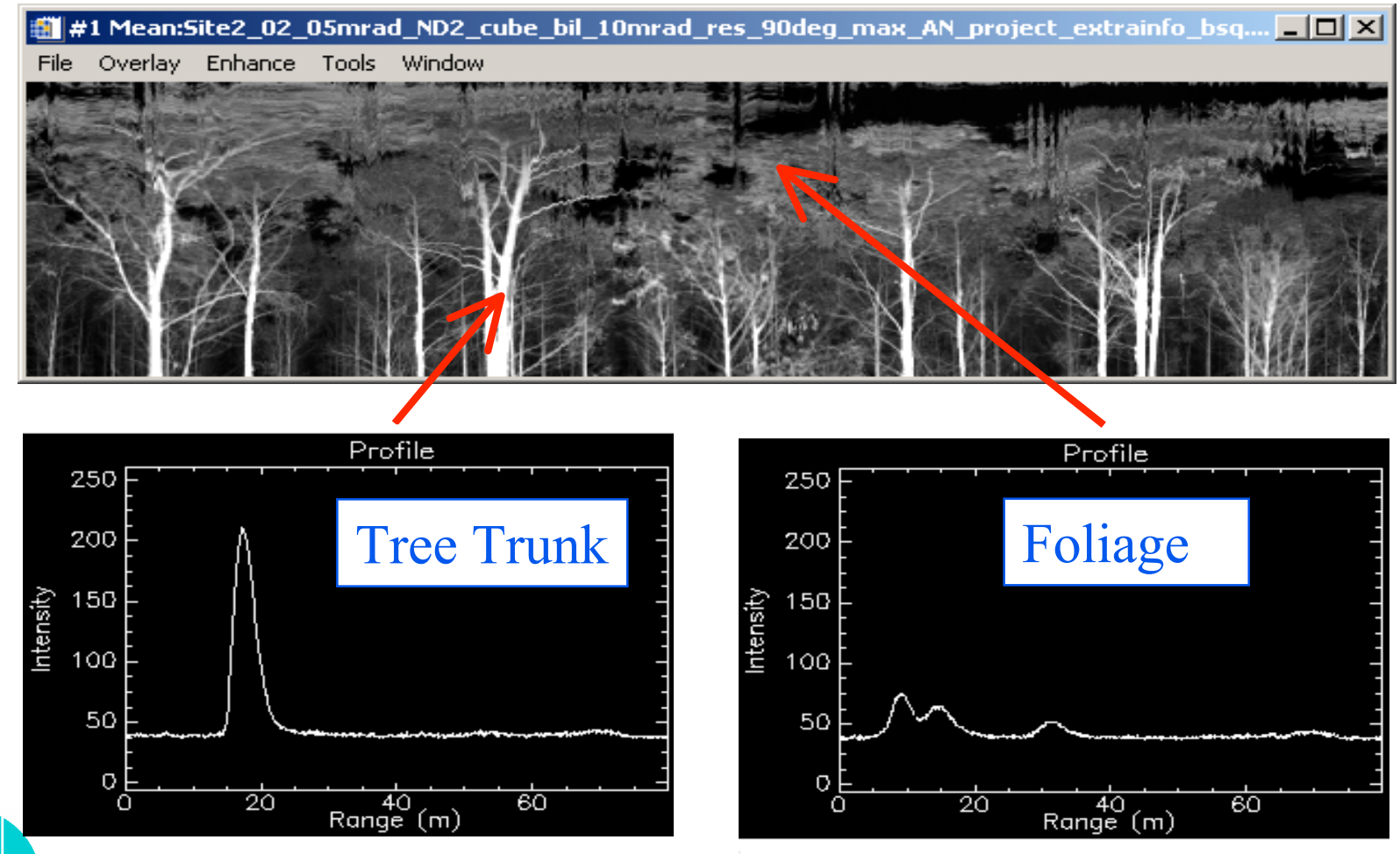
EVI provides returned Lidar power from all directions of the hemisphere as a function of time (range) following a laser pulse output with peak power at time tp.



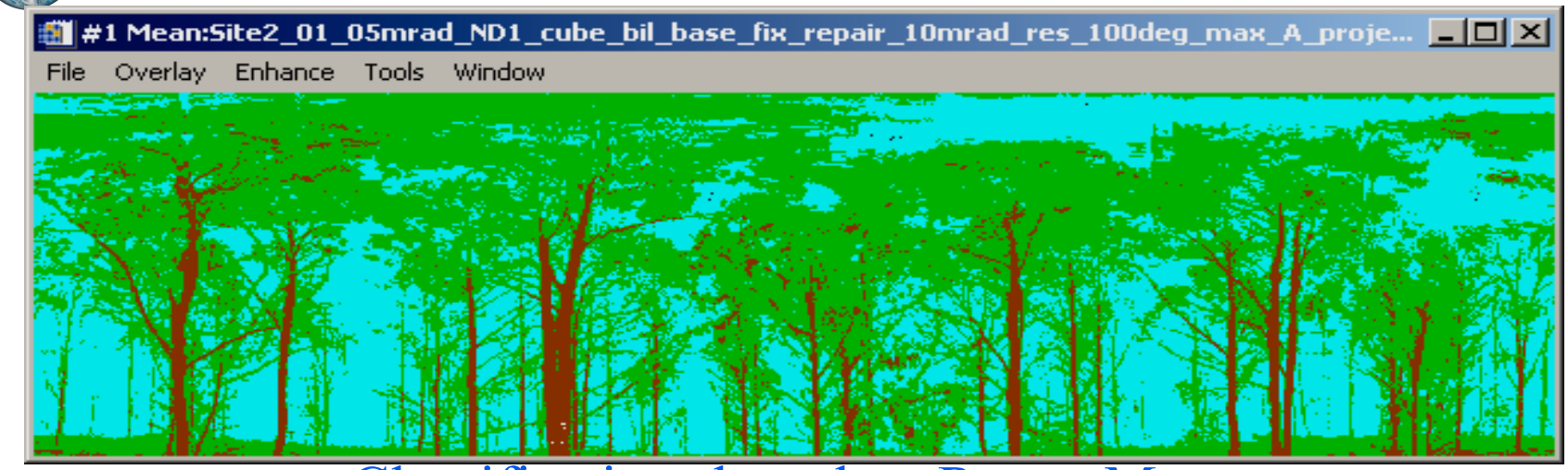


↑ Azimuth ↓

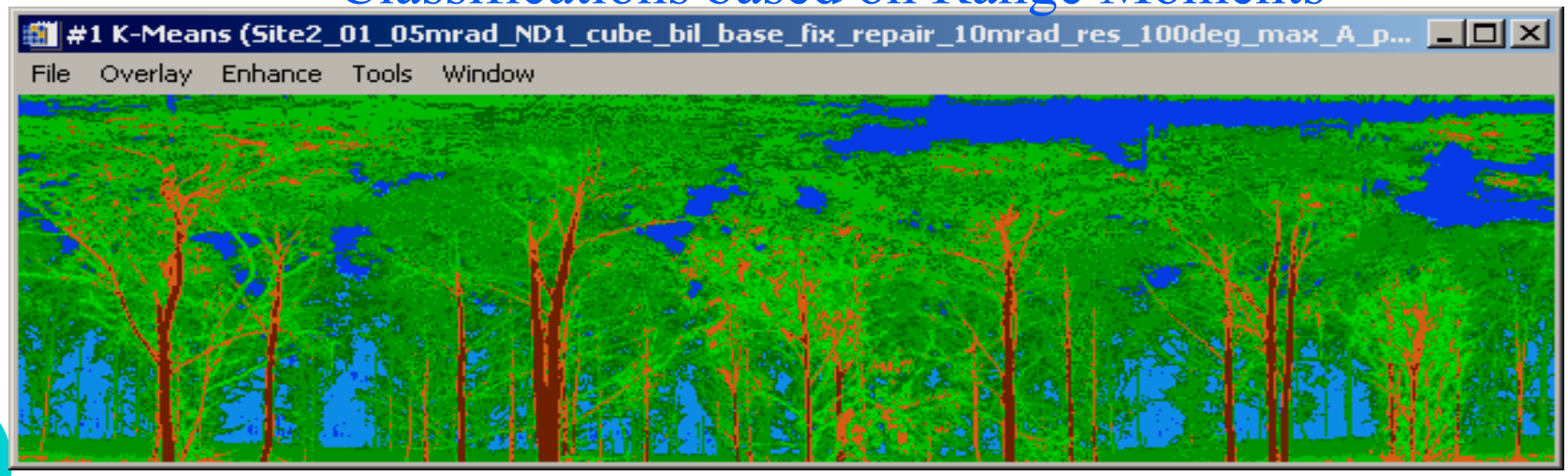
Hard & Soft Returns in EVI Data



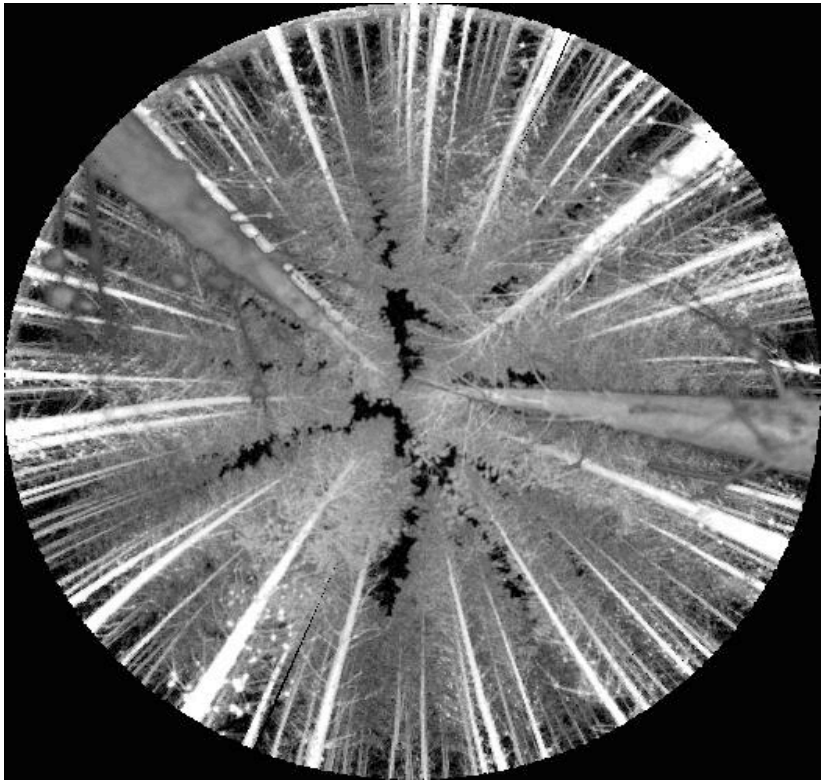
Separating components in Plate Carré



Classifications based on Range Moments



ECHIDNA™ Data Projections



Hemispherical

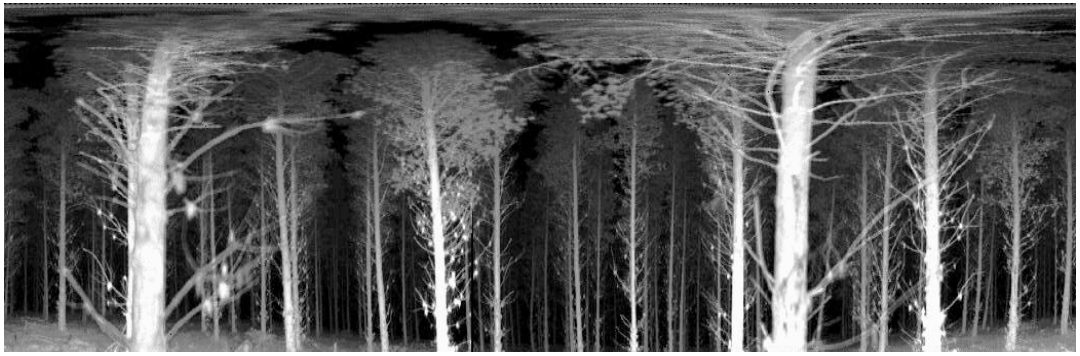
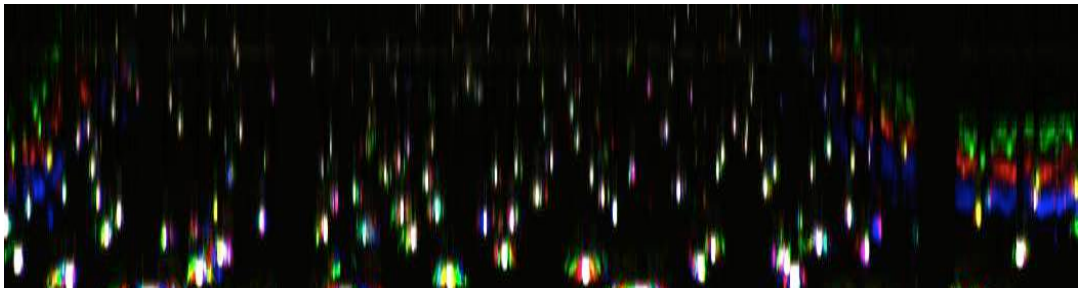
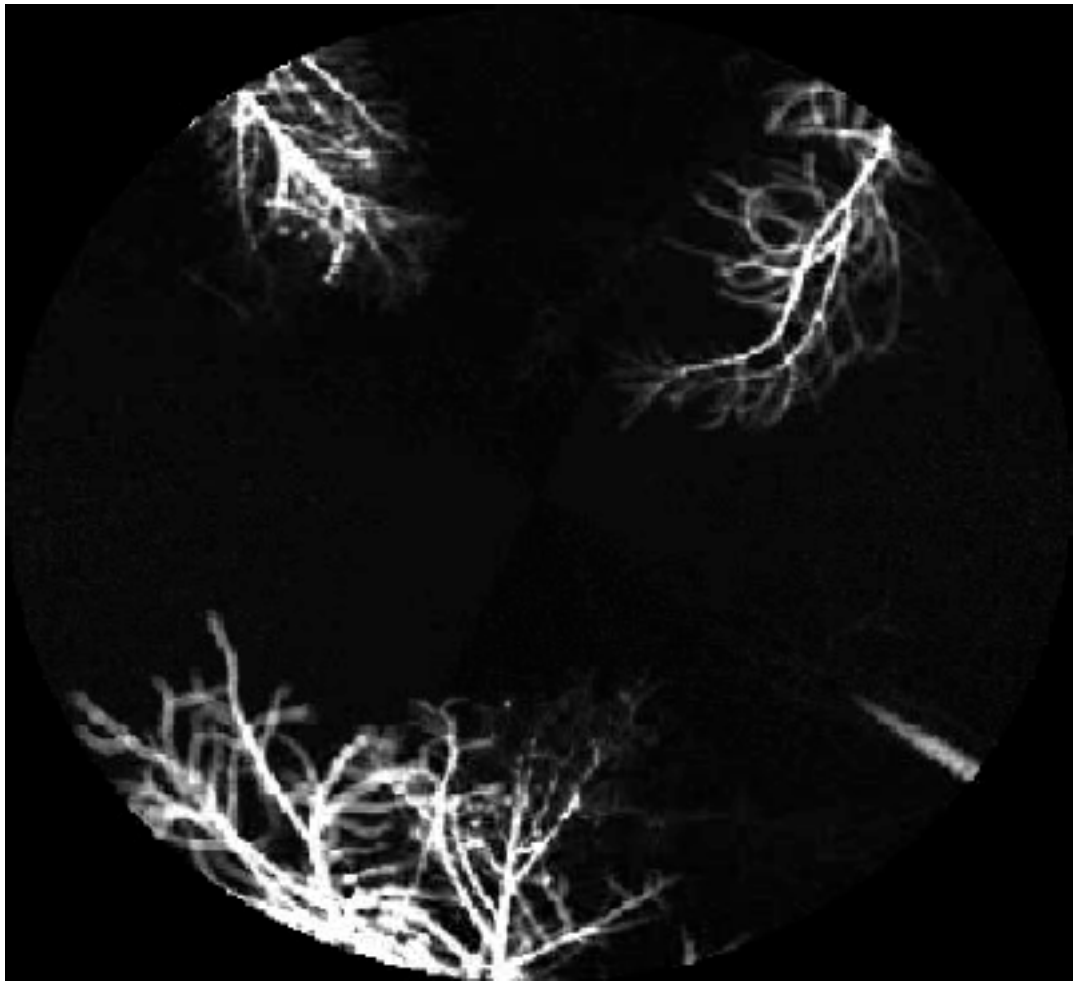


Plate Carré (simple cylindrical)

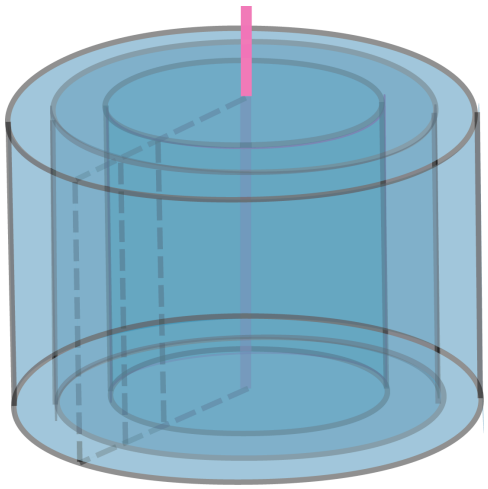


Horizontal & Radial Slices

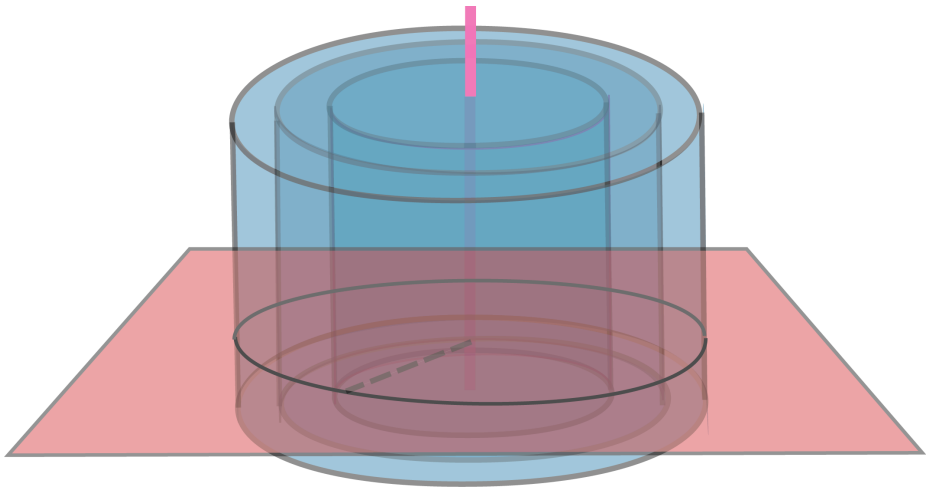
MPeg of Hemispherical Scan



Cylindrical projection shows layers of uniform horizontal distance from the instrument

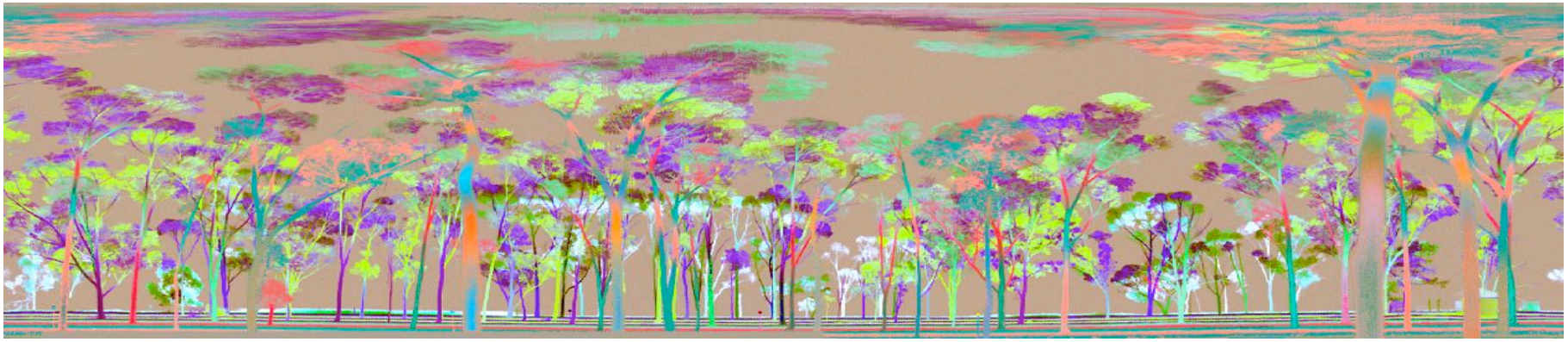


Cut vertical cylinders and unwrap: constant distance



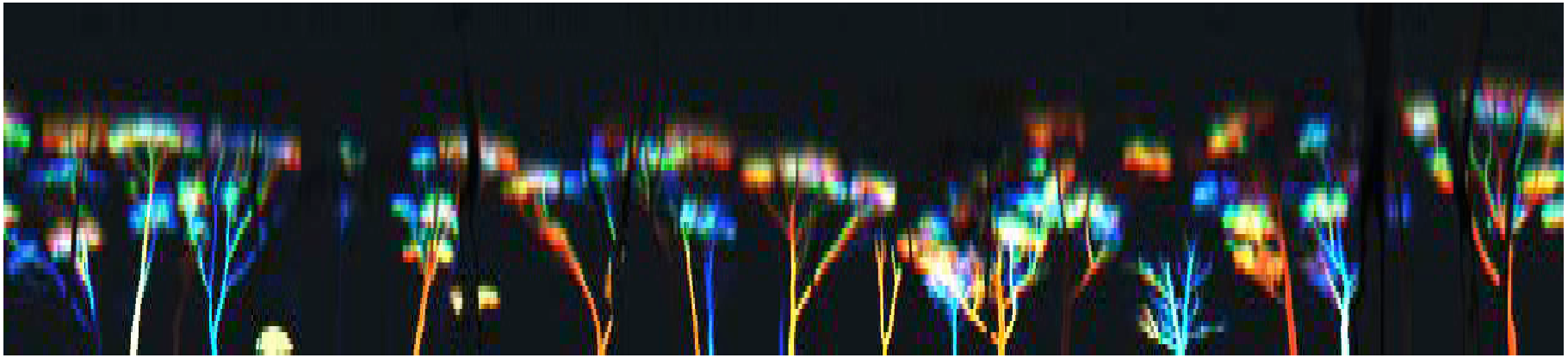
Slice through cylinders: constant height

The data can be “sliced” by radial distance providing tree silhouettes



← Zenith →

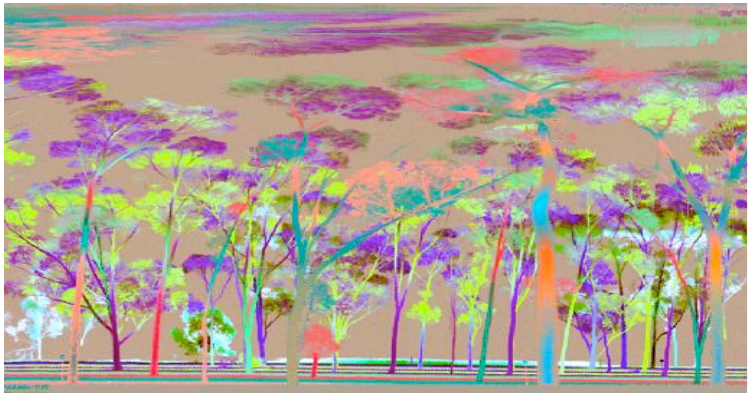
Range Moments 18, 20 & 22 (comparison)



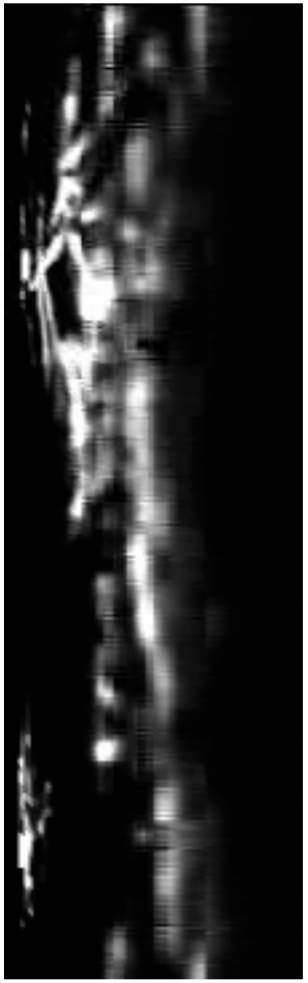
← Height →

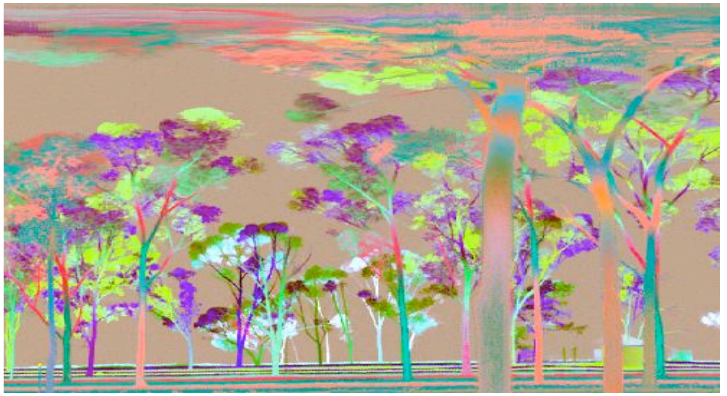
Range Slice 15-17 m away from and above EVI
for branching, defect and shape of stems

The data can be “sliced” by radial distance providing tree silhouettes



Range Momen

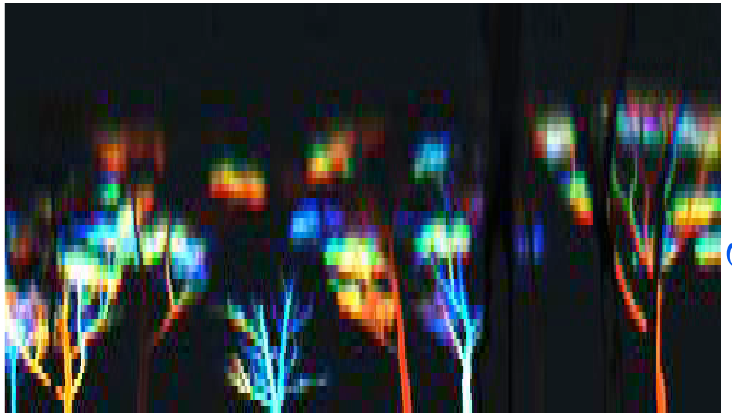




mparison)

← Zenith →

Range Slice 15·

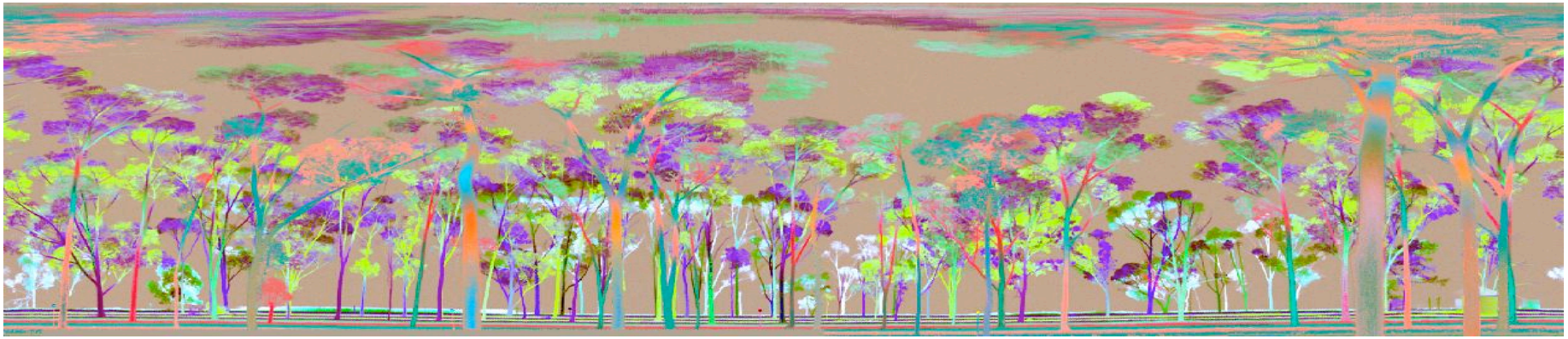


ınd above EVI

← Height →

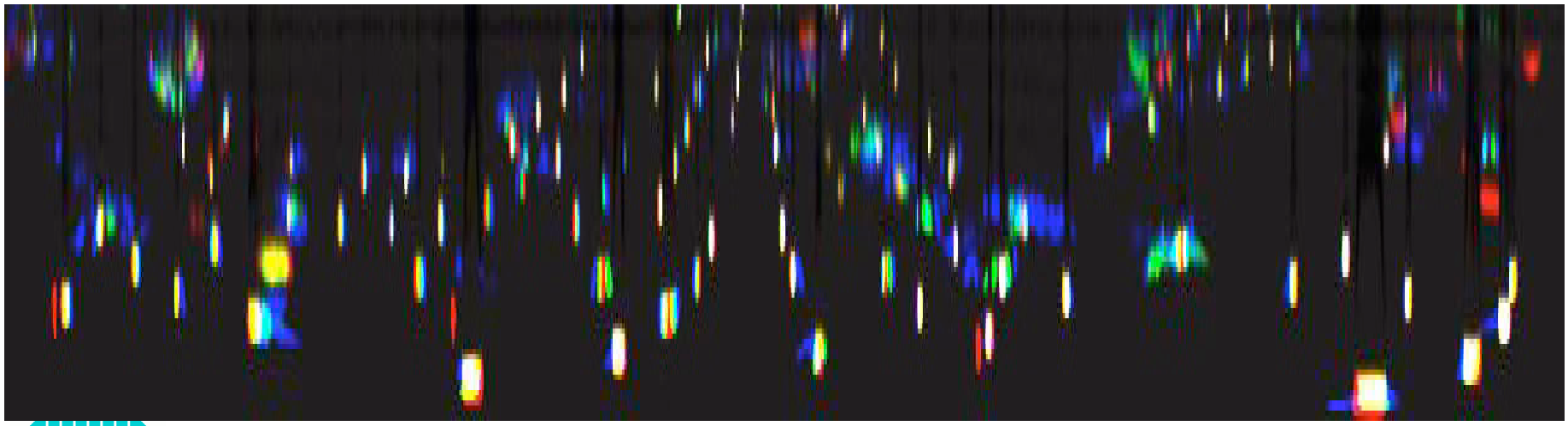
for branching, defect and shape of stems

The data can be “sliced” by height providing stem plots and horizontal canopy slices



← Zenith →

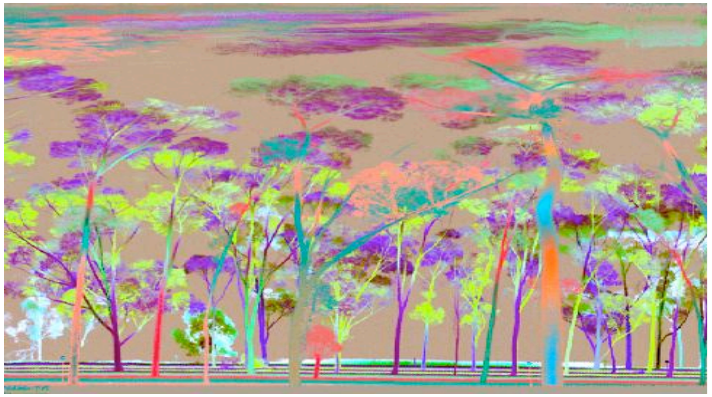
Range Moments 18, 20 & 22 (for comparison)

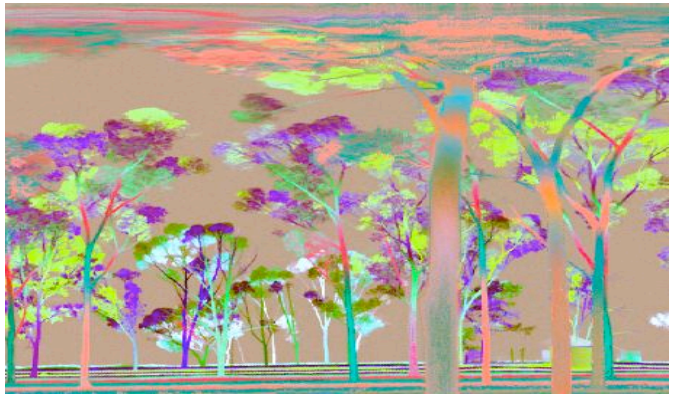


← Radius →

Height Slices 0.25, 1.75 & 3.75 m above EVI provide stem information

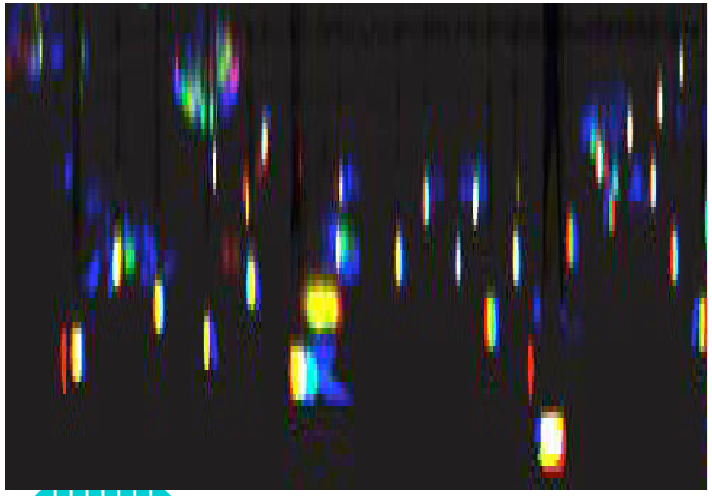
The data can be “sliced” by height providing stem plots and horizontal canopy slices

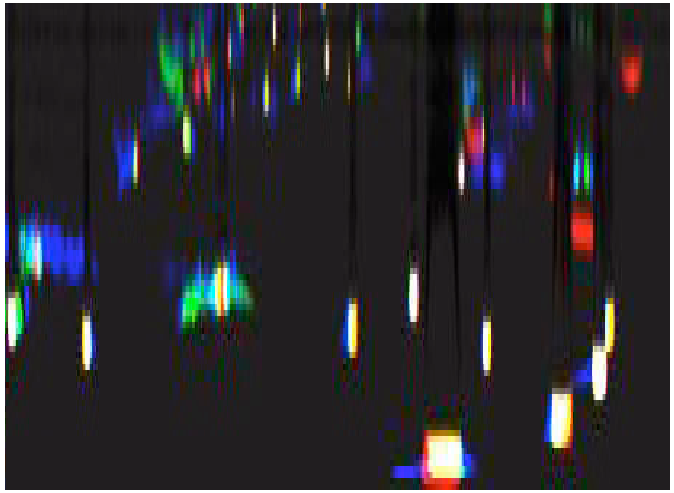




← Zenith →

Range Mom ɔmparison)

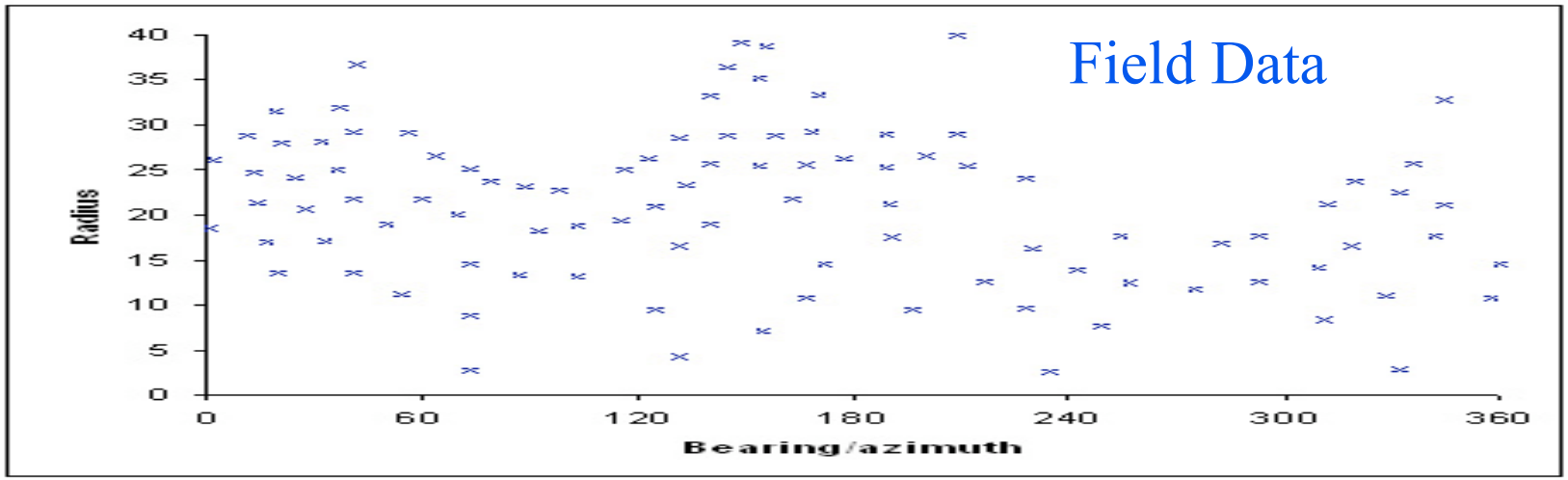




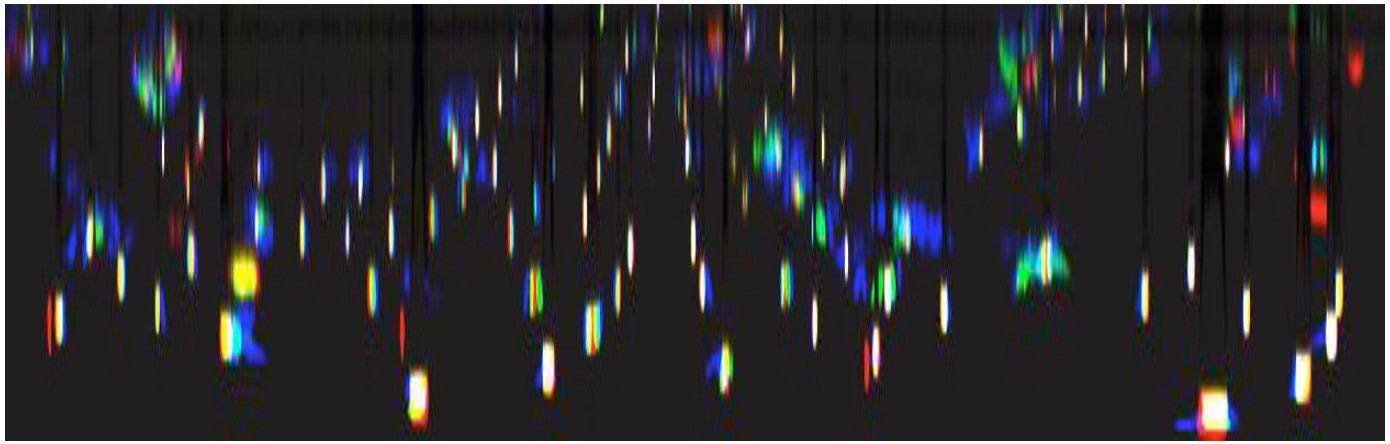
← Radius →

Height Slices 0.25, 1.75 & 3.75 m above EVI provide stem information

Field Data Stem Plot & EVI Stem Plot

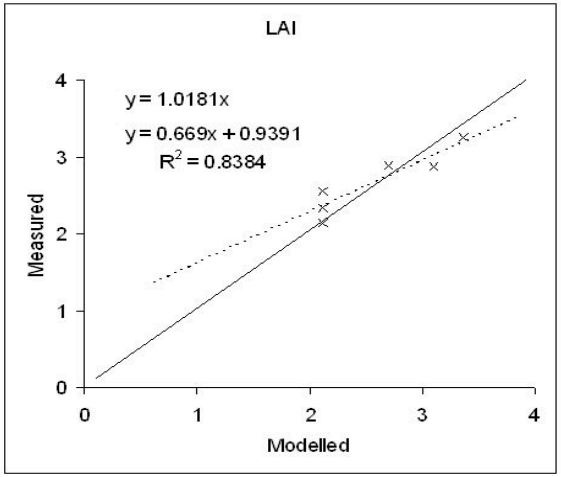


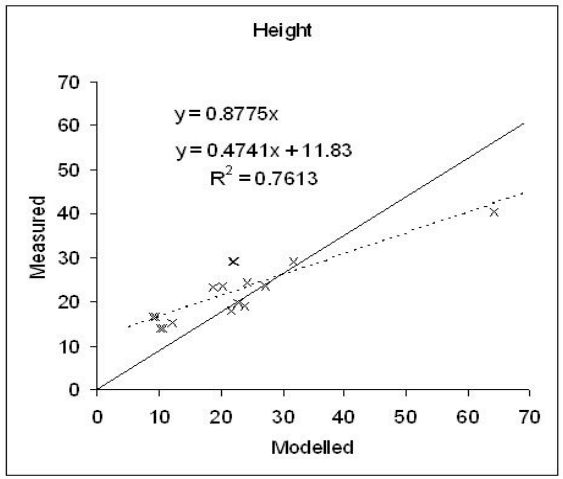
EVI

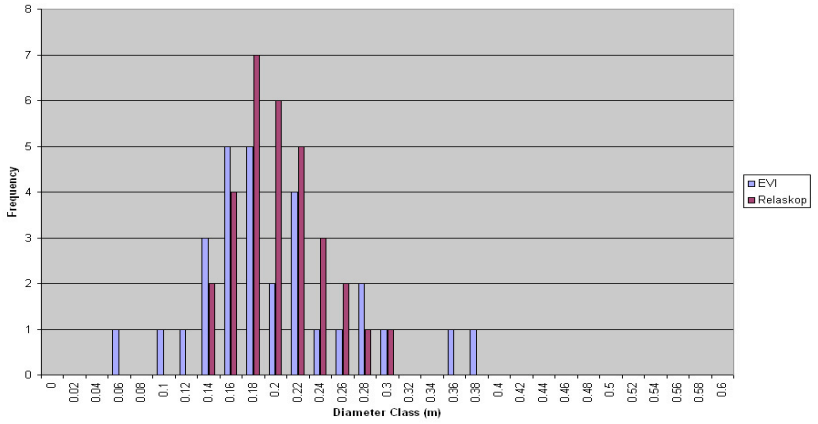


← Radius →

ECHIDNA™ Products – height, LAI & stem location, size distribution, and density







Applications of ECHIDNA™

- Primary Information
  - Foliage profile & LAI
  - Stocking, Basal Area & DBH distribution
  - Stem maps and identification
  - Tree silhouettes
  - Bole height & branching
- In Progress
  - Stem form factor, taper and sweep (for volume by size class)
  - Separating branches and foliage
  - Allometry from ground to airborne data
- The potentials in forestry & ecology are almost unlimited